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HERPETOFAUNA ASSOCIATED WITH PALM OASES ACROSS THE CALIFORNIAN-SONORAN TRANSITION IN NORTHERN BAJA CALIFORNIA, MEXICO

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ABSTRACT—Ecological boundaries have been of interest to naturalists since the time of Darwin and Wallace because they are transitional zones on the landscape across which distinct changes occur in constitution of plant and animal communities. In the xeric landscapes of the central Baja California Peninsula, fan palm (*Erythea armata* and *Washingtonia robusta*) oases are small (usually <1 ha) mesophilic islands of structurally complex habitats. We report new records of mesophilic reptiles and amphibians from the adjacent Californian biome in palm groves of the Sonoran region; these highly philopatric species provide evidence of earlier cooler and moister Pleistocene environments. The fan palm oases of the central Baja California Peninsula are natural laboratories for the study of evolutionary processes because they provide unique mesic habitats in a changing desert landscape.

RESUMEN—Los límites ecológicos han sido de interés para los naturalistas desde los tiempos de Darwin y Wallace debido a que son zonas de transición en el paisaje donde ocurren cambios en la estructura de comunidades de plantas y animales. Los oasis de palma de abanico (*Erythea armata* y *Washingtonia robusta*) presentes en los ambientes xéricos de la región central de la península de Baja California, México, son pequeñas islas mesofílicas (usualmente <1 ha) de hábitats estructuralmente complejos. Reportamos nuevos registros de reptiles y anfibios de ambientes mesofílicos del adyacente bioma californiano en palmares de la región sonorense; estas especies altamente filopátricas proveen evidencia de previos ambientes más húmedos y menos cálidos del Pleistoceno. Los oasis de palma de abanico de la región central de la península de Baja California son laboratorios naturales para el estudio de los procesos evolutivos porque proveen hábitats mesofílicos únicos en los paisajes cambiantes del desierto.

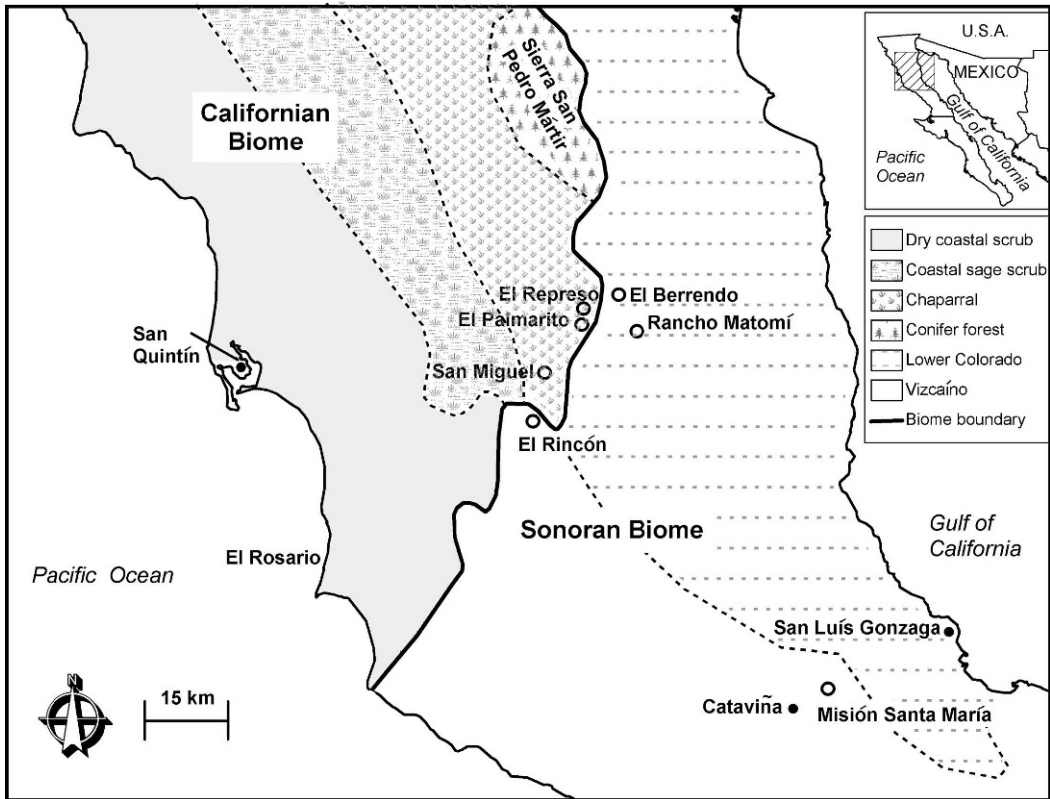


FIG. 1—Phytogeographic provinces of northern Baja California, Mexico. Study sites are indicated by open circles and closed circles are towns.

The central one-third of the Baja California Peninsula presents one of the most clearly defined transitions from Mediterranean-type (winter rain) to tropical (summer rain) climate in the world. This portion of the Sonoran Desert, known as the Central Desert of Baja California, is characterized by drought and unpredictability in seasonality of precipitation (Hastings and Turner, 1965; Franco-Vizcaíno, 1994). Here, we examined records of amphibians and reptiles from seven oases of blue fan palms (*Erythea armata*) across the Californian-Sonoran ecological transition, from a fairly predictable winter rainfall regime (Californian) to a region of unpredictable timing of precipitation (Sonoran).

Three oases (El Represo, El Palmarito, and San Miguel) occur within coastal scrub and chaparral assemblages at the southern end of the Sierra San Pedro Mártir (Californian Phytogeographic Province) where they occur as small, isolated mesic habitats along the southernmost boundary of this region. The

remaining four sites were mesic desert palm oases surrounded by xeric plant assemblages within the Lower Colorado (El Berrendo and Rancho Matomí) and Vizcaíno (El Rincón and Misión Santa María) phases of the Sonoran Phytogeographic Province (Murvosh, 1994; Franco-Vizcaíno et al., 2007; Fig. 1). Misión Santa María contains desert fan palms (*Washingtonia*; Grismer and McGuire, 1993), in addition to blue fan palms.

Responses of organisms to differences in timing and reliability of moisture across this Californian-Sonoran transition zone are of interest to ecologists. These oases are islands of reliable moisture, with those of the Californian Province providing possible source sites for mesic species to migrate east or south to oases in the Lower Colorado or Vizcaíno phases of the Sonoran Desert; alternatively, all of these oases may be acting as refugia for previously widespread mesophilic species whose ranges have contracted during Holocene drying. Several amphibians

TABLE 1—Lizards, snakes, and frogs trapped or observed at seven palm oases in northern Baja California, Mexico.

Location	Taxon	Number of voucher specimens (number of visual observations)
El Berrendo	<i>Pseudacris cadaverina</i>	(3)
	<i>Petrosaurus mearnsi</i>	(1)
	<i>Plestiodon gilberti</i>	2
	<i>Sceloporus orcutti</i> (?)	1
	<i>Urosaurus graciosus</i>	1, (1)
	<i>Urosaurus nigricaudus</i>	4
	<i>Uta stansburiana</i>	(multiple)
El Represo	<i>Aspidoscelis tigris</i>	1
	<i>Urosaurus nigricaudus</i>	9
	<i>Uta stansburiana</i>	(multiple)
El Palmarito	<i>Bufo punctatus</i>	3
	<i>Aspidoscelis tigris</i>	1
	<i>Plestiodon gilberti</i>	1, (2 juveniles)
	<i>Plestiodon skiltonianus</i>	(1)
	<i>Petrosaurus mearnsi</i>	(2)
	<i>Sceloporus occidentalis</i>	2
	<i>Urosaurus nigricaudus</i>	17, (multiple)
	<i>Pseudacris cadaverina</i> ^a	(4)
	<i>Uta stansburiana</i>	(multiple)
Rancho Matomí	<i>Urosaurus nigricaudus</i>	1
	<i>Pseudacris cadaverina</i>	1
	<i>Uta stansburiana</i>	(multiple)
El Rincón	<i>Aspidoscelis hyperythra</i>	3, (multiple)
	<i>Aspidoscelis tigris</i>	(multiple)
	<i>Urosaurus nigricaudus</i>	5
	<i>Pseudacris cadaverina</i>	(3)
	<i>Pseudacris regilla</i>	(1)
	<i>Uta stansburiana</i>	(multiple)
	<i>Thamnophis hammondi hammondi</i>	(2)
	<i>Bufo punctatus</i>	(1)
	<i>Phrynosoma coronatum</i>	(1)
Misión Santa María	<i>Urosaurus nigricaudus</i>	(multiple)
	<i>Uta stansburiana</i>	(multiple)
	<i>Pseudacris cadaverina</i>	(multiple)
	<i>Pseudacris regilla</i>	acoustic observation
	<i>Callisaurus draconoides</i>	(3)
	<i>Crotaphytus</i> sp.	(1)
San Miguel	<i>Urosaurus nigricaudus</i>	4
	<i>Uta stansburiana</i>	(multiple)
	<i>Thamnophis hammondi hammondi</i>	(2)

^a Observed in Arroyo Rosarito west of El Palmarito.

(e.g., Pacific treefrog *Pseudacris regilla*, California treefrog *P. cadaverina*) and several mesophilic reptiles (e.g., two-striped garter snake *Thamnophis hammondi*, California striped racer *Masticophis lateralis*) that are fairly widespread in the Californian Province, have widely fragmented distributions associated with palm oases to the south in the central peninsula (Grismer, 2002).

Specimens of lizards and frogs were collected incidentally in pitfall traps set for arthropods at El Palmarito (3 May 2001–21 March 2002), El Represo (2 May 2000–19 March 2002), El Rincón (18 February 2001–20 March 2002), and San Miguel (18 February 2001–20 March 2002). Pitfall traps consisted of buried cans covered by large protective rocks with a layer of ethylene

glycol in the bottom; these often were left in the field for extended periods (Clark and Blom, 1992). We also used visual-encounter surveys at these oases and at El Berrendo (14 February 2004, 30 December 2005–2 January 2006), El Palmarito (21 March 2002, 12 November 2003, 12 November 2004), El Rincon (25 February 2000, 2 May 2000, 22 March 2002, 11 November 2003), Rancho Matomí (14 February 2002), and Misión Santa María (19 March 2002; Fig. 1). The seven oases were sampled periodically during February 2001–January 2006 (Table 1). We detected 2 species of tree frogs (Hylidae), 1 species of toad (Bufonidae), 1 species of snake (Colubridae), and 12 species of lizards (Phrynosomatidae, Scincidae, and Teiidae; Table 1).

We report for the first time, a population of the Pacific treefrog (*Pseudacris regilla*) at Misión Santa María, where they occurred sympatrically with the California treefrog (*Pseudacris cadaverina*; Table 1). Grismer (2002) indicated that populations of the Pacific treefrog occurred southeast of this locality in what appears to be Arroyo San Francisquito. Grismer and McGuire (1993) first reported *P. cadaverina* at Misión Santa María and Grismer (2002) recorded it at adjacent Arroyo Santa Maria. However, the distribution map in the later reference appeared to omit Misión Santa María; thus, extending the range only to Las Palmas (Grismer, 2002). We also report a newly discovered population of *P. cadaverina* in Arroyo Rosarito south of El Palmarito (Fig. 1).

Captures of Gilbert's skink (*Plestiodon gilberti*) at El Berrendo and El Palmarito (Table 1) represent about a 60-km extension of the range south from La Grulla in the Sierra San Pedro Martír (Welsh, 1988; Grismer, 2002). The capture of a western skink (*Plestiodon skiltonianus*) at El Palmarito is also about a 55-km extension of the range southward from El Remudero (El Horno) in the Sierra San Pedro Martír (Welsh, 1988). These two species were syntopic at El Palmarito (cf., Morrison et al., 1999). Richmond and Reeder (2002) presented evidence of three distinct clades of *P. gilberti* in western North America, all of which nest phylogenetically within the *P. skiltonianus* complex. They believed that the three lineages of *P. gilberti* represented parallel instances (i.e., convergent evolution) of ecological speciation (Schluter, 2001) within the *P. skiltonianus* complex (Richmond and Reeder, 2002).

Collection of a long-tailed brush lizard (*Urosaurus graciosus*) at El Berrendo fills the distributional gap of the species (ca. 145 km). This species ranges throughout the northeastern portion of the peninsula south to at least San Felipe, with a disjunct population in Bahía San Luis Gonzaga (Grismer, 2002). This record is 56 km SW San Felipe and 117 km NW Bahía San Luis Gonzaga.

Our detection of a western fence lizard (*Sceloporus occidentalis*) at El Palmarito (Table 1) adds to the previously known southern distributional limit (15 km E Rancho Socorro; Grismer, 2002). El Palmarito is 40 km ENE Rancho Socorro. The remaining lizards we detected (Table 1) range widely throughout this region of Baja California (Grismer, 2002) where they occur in the plant assemblages and more xeric habitats surrounding these oases (Fig. 1).

We have added to the herpetofauna of these palm oases with new records of mesophilic species (Grismer, 2002). We interpret this collection of species as supporting the hypothesis that these palm oases are relictual ecosystems because it is highly unlikely these mesophilic species could disperse across surrounding arid environments to populate other remote and isolated mesic habitats. Grismer and McGuire (1993) studied composition of the herpetofauna of 31 oases throughout central Baja California and emphasized their importance as refugia for relictual mesophilic species. They believed that presence of relictual mesophilic species in these xeric environments gave evidence of an earlier cooler and moister Pleistocene environment in this part of the peninsula (e.g., Betancourt et al., 1990). We concur with this interpretation and add that we believe these oases provide natural laboratories for the study of evolutionary processes because they provide unique habitat and micro-environmental stability in a changing landscape; including climatic change, where many life forms must face stasis, adaptation, or extinction in a changing environment.

Lizards captured in pitfall traps were collected under permit NUM/SGPA/DVGS/03338 issued by the Ministry of the Environment, Secretaría del Medio Ambiente y Recursos Naturales. Specimens were deposited in the collections of the Orma J. Smith Museum of Natural History, College of Idaho, Caldwell, Idaho, and the herpetological collection of the Facultad de Ciencias, Universidad Autónoma de Baja California in Ensenada. C. R. Peterson verified identifications of

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